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Violence Exposure and the Development of School-Related Functioning: Mental Health, Neurocognition, and Learning

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Abstract

The relation between history of violence exposure and the development of academic and mental health problems is explored. Violence exposed children have an increased risk of developing school-related problems including: mental health problems, learning disabilities, language impairments, and other neurocognitive problems. These problems interact to create a complex web of deficits and disabilities where intervention access points are difficult to assess. Often mental health problems and academic problems develop in parallel. Timing of violence exposure and the developmental stage of the child during exposure complicate our understanding of the underlying mechanism. A model is presented that explores pathways linking violence exposure to aspects of school-related functioning, both academically and behaviorally. Early life stress, in the form of violence exposure, is related to neurocognitive deficits, including executive functioning and problems in self-regulation. Deficits in self-regulation at the level of behavior, and cognitive control and executive functioning, at the level of brain processing, are related to both academic and mental health problems, suggesting a possible psychological mechanism. Biological mechanisms are also included in the model to illustrate the contribution of the stress response, neuroendocrine system response, and neuroanatomical structural and functional impairments associated with violence exposure.

Keywords

Child maltreatment; language impairment; disability; externalizing behavior; internalizing behavior; self-regulation

Introduction[1]

Exposure to violence is related to problems in school functioning, including mental health, cognitive processing and language development. These problems interact to create a

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[1]Abbreviations: 5-HT = serotonin, ADHD = Attention Deficit Hyperactivity Disorder, AFDC = Aid for Families with Dependent Children, CD = Conduct Disorder, CPS = Child Protective Service, DA = dopamine, LD = Learning Disability, LI = Language Impairment, MAOA = monoamine oxidase A, NE = norephinephrine, ODD = Oppositional Defiant Disorder, PTSD = Posttraumatic Stress Disorder.

complex web of disabilities where intervention access points are difficult to assess. Children with histories of violence exposure are often referred for mental health services at an early age and frequently develop emotional, and behavioral disorders. The cost to both individuals and to society is large. One in eight children experiences some form of maltreatment (Finkelhor, Ormrod, Turner, & Hamby, 2005), as either abuse or the neglect of proper care. Abuse has particular repercussions for the development of school skills such as language learning, cognitive processing and self-regulation. Interpersonal violence and community violence experienced in childhood are related to myriad psychosocial problems including, attachment problems, speech, language and social interactions, delays in emotion processing, and intellectual and behavior problems (Azar & Wolfe, 2006). A better understanding of the developmental trajectory of the relation between school-related function and violence exposure, at both the level of behavior and the level of brain development, will help to guide research and intervention toward sensitive periods in development.

There are critical turning points in the parallel development of emotion regulation and academic skills in children exposed to violence that deserve further study. Violence exposure during childhood happens in concert with critical periods in language and social development, from infancy through adolescence. Violence exposure, particularly family violence, can wreak havoc on the development of neural circuits underlying basic mechanisms of affective and cognitive development (Andersen, Tomada, Vincow, Valente, Polcari, & Teicher, 2008; Choi, Jeong, Rohan, Polcari, & Teicher, 2009; Miskovic, Schmidt, Georgiades, Boyle, & Macmillan, 2010; Seckfort et al., 2008, Sheu, Polcari, Anderson, & Teicher, 2010). There is no longer any doubt that the assault of violence, both through physical or psychological trauma, can and does disrupt the process of normal child development.

Children with a history of violence exposure follow certain developmental trajectories, often withdrawing socially or behaviorally regressing, which can cause problems with peer relationships, especially in demanding social settings, such as in school. At the level of the brain, children exposed to violence may exhibit neurological changes that lead to problems of cognition in memory, executive functioning (the ability to organize and synthesize information), self-regulation, language causing learning delays or disabilities (De Bellis, Hooper, Spratt, & Woolley, 2009; De Bellis, Hooper, Woolley, & Shenk, 2009; DePrince, Weinzierl, & Combs, 2009; El-Hage, Gaillard, Isingrini, & Belzung, 2006;Seckfort et al., 2008; Watts-English, Fortson, Gibler, Hooper, & De Bellis, 2006). Integrating research from a number of fields, we review the confluence between violence exposure, mental health problems, language learning, neurocognitive development and disabilities.

Violence exposure, as used here, refers to violence in the community and family. Generally, exposure to interpersonal violence, whether witnessing violence between caregivers or direct child maltreatment, has a more negative impact on children than does exposure to community violence and is the focus of many of the studies reviewed here. The term maltreatment is understood to include both child abuse and neglect. Child abuse encompasses physical, sexual and emotional abuse of a child. Often individual studies reviewed here focus more discreetly on one of the specific aspects of maltreatment, but we use the term more broadly to refer to any subset of child abuse and neglect. The rationale for the use of the broad term, violence exposure, is two fold. First, multiple studies have shown exposure to one form of violence increases the likelihood of exposure to other forms of violence and also outcomes of violence exposure vary based on severity, developmental stage of the child, and the individual child's developmental trajectory making violence type specific mechanisms unlikely (Andersen, Tomada, Vincow, Valente, Polcari, & Teicher, 2008; Margolin, Vickerman, Oliver & Gordis, 2010). In other words, children who

experience one form of violence can have a variety of social and emotional behavioral outcomes and children who experience another form of violence may have the same diversity of outcomes. This necessitates the discussion of violence exposure more broadly.

It is also necessary to say a word about mental health problems as they relate to school function. A number of different disorders that fall under the broader umbrella of externalizing disorders (ADHD, Conduct Disorder (CD), Oppositional Defiant Disorder (ODD), and Autism) and internalizing disorders (anxiety, depression, and posttraumatic stress disorder (PTSD)) impact school function. Many children exhibit both internalizing and externalizing problems simultaneously (Graham-Bermann, Gruber, Girz & Howell, 2009; Hudziak, Achenbach, Althoff, & Pine, 2007). In addition, limited cognitive function, problems with executive functioning, diagnosed language impairments (LI), delayed language development, diagnosed learning, reading or math disorders, and school failure are within the Diagnostic and Statistical Manuel category of disorders most often diagnosed in childhood.

For purposes of this paper, we consider school related academic issues as separate from mental health in order to elucidate the transactional relation between school functioning and mental health. Theoretically, a specific learning disorder could be the cause of a specific behavioral disorder or vise versa. More likely, there is multifinality in the way that behavioral disorders transact within a particular child and family context. The purpose of this review is to examine this complex relation, to examine the role of violence in mental health and academic development and to propose a model of the role of violence in the development of both academic and mental health problems (see Graphical Abstract).

Violence Exposure and Functioning

Mental Health—Violence exposure in various forms has been related to problems in the development of psychosocial health in some children and adolescents. Although many people show great resilience after violence exposure, exposure to violence in the home and community is a precursor to the development of externalizing and internalizing mental health problems in some, with the degree of exposure determining the extent of the problem (Buckner, Beardslee, & Bassuk, 2004; Finzi-Dottan, Dekel, Lavi, & Su'ali, 2006; Lewis et al., 2010; Ozer & McDonald, 2006; Ruchkin, Henrich, Jones, Vermeiren, & Schwab-Stone, 2007). National lifetime rates of witnessing community violence as a child are around 30% (Finkelhor, Ormrod, Turner, & Hamby, 2005), but rates differ based on community. Children who experience one form of violence are much more likely to experience community violence with rates close to 100% if children report other violence exposure (Turner, Finkelhor, & Ormrod, 2010). In a population of homeless children, researchers found the rate of exposure to community violence to be over 60% (Buckner, Beardslee, & Bassuk, 2004). In urban populations rates of community violence exposure have been found to be as high as 70% (Thompson & Massat, 2005).

Although total community violence exposure predicts both internalizing and externalizing mental health problems, in the Buckner study, this was particularly salient for internalizing mental health problems where greater exposure was salient for both genders but was particularly salient for girls in the manifestation of internalizing. Of note, the authors also found self-regulatory ability to mediate this relation. Self-regulation has been found in a number of studies to be a salient mediator and at the brain level, in the form of executive function or cognitive control, is a possible mechanism for the development of both mental health and academic problems following exposure to violence.

Exposure to violence in the home, either witnessing violence between parents or experiencing direct violence, is also a precursor of the development of mental health

problems (English et al., 2005; English, Marshall, & Stewart, 2003; Hanson et al., 2008; Kim & Cicchetti, 2009; Perkins, Cortina, Smith-Darden & Graham-Bermann, 2012; Ybarra, Wilkens, & Lieberman, 2007). The rate at which violence exposure is predictive differs based on gender and violence type (Hanson et al., 2008). In general, violence more than doubles the risk of development of PTSD and depression. Sexual abuse is most commonly experienced by girls and is the highest predictor of PTSD, at triple the rate, and equal to physical violence in predicting depression (Hanson et al., 2008). Among boys, sexual abuse is particularly damaging. Although boys experience sexual abuse less commonly, risk of the development of PTSD in boys is more than five times (Hanson et al., 2008).

Age of first exposure, frequency of exposure and exposure to multiple types of violence are important variables to consider in the development of mental health problems. In a study of children referred to child protective service for child abuse and neglect, multiple types of abuse and chronicity of abuse predicted internalizing mental health problems (English et al., 2005). In the same study, externalizing was most predicted by the earlier age of first exposure. Considering that in early childhood one of the core developmental tasks is the development of social interactions with others, it would make sense that early exposure to violence would disrupt that process and make children more vulnerable to developing externalizing behaviors. The authors examined later social competence in this population and found that chronicity of violence, physical abuse, age, and multiple types of abuse predicted deficits in social competence (English et al., 2005). Although they did not measure self-regulatory capacity directly, self-regulation of emotional response is central to social competence. There is evidence that in addition to a direct relation between abuse and mental health problems, peer-rejection and self-regulation may mediate this relation (Kim & Cicchetti, 2009; Perkins, Cortina, Smith-Darden & Graham-Bermann, 2012).

In another study, total CPS referrals also predicted child health problems, including physical disabilities, emotional disorders and learning disorders, underlying the complex relations between psychopathology and academic problems (English, Marshall, & Stewart, 2003). Finally, school-related violence, which is an often over-looked area of violence scholarship, is important in the lives of children and can be related mental health problems (Flannery, Wester, & Singer, 2004).

Academic Achievement—In terms of language and academic achievement, community and interpersonal violence exposure have been related to more negative outcomes. Children with exposure to child abuse and neglect have twice the rate of referral for special education (Jonson-Reid, Drake, Kim, Porterfield, & Han, 2004). In this prospective study of children who received Aid for Families with Dependent Children (AFDC), matched based on later substantiated maltreatment, 19% of the total sample entered special education later at a mean age of eight years old. Among the children from AFCD backgrounds without a CPS referral the rate was 14%, but was 24% for the maltreated group. Developmental risk factors as well as demographic factors, such as being male and African American, were associated with entry into special education. Developmental risk, when combined with maltreatment, increased the relation to later special education. In terms of abuse, physical abuse increased the rate for later special education by 50%. The researchers found that children with physical abuse had a heightened risk of serious emotional disturbance (SED), neglect was related to mental retardation, sexual to learning disability and mixed abuse to child delay and other health problems. Full-scale IQ deficits have also been found in children with community violence exposure (Ratner, Chiodo, Covington, Sokol, Ager, & Delaney-Black, 2006), domestic violence exposure (Ybarra, Wilkens, & Lieberman, 2007), neglect (Noble, Tottenham, & Casey, 2005), and child abuse (De Bellis, Hooper, Spratt, & Woolley, 2009; Perkins, Smith-Darden & Graham-Bermann, 2011).

Community violence and child abuse are both related to lower reading ability (De Bellis, Hooper, Spratt, & Woolley, 2009; Ratner, Chiodo, Covington, Sokol, Ager, & Delaney-Black, 2006). In a large urban sample, Ratner and colleagues found that violence victimization was related to lower overall ability and comprehension at a trend level. Interestingly, they also found that a feeling of protection at home and school was related to higher reading ability and comprehension (Ratner et al., 2006). In addition, child neglect has been related to deficits in vocabulary, language processing speed, memory and measures of attention and executive processing (De Bellis et al., 2009). For maltreated children, memory may be particularly salient in the connection between violence exposure and development of PTSD (De Bellis et al., 2009).

Potential Pathways—Violence exposures can cause neurocognitive and language processing problems through two pathways: neurological changes directly resulting from the violence exposure, and differences in exposure to interpersonal communication and language over the course of development, including number of words and type of speech (see Figure 1). In the first instance, violence exposure can be a direct cause of academic problems and disabilities through brain injury. In fact, rates of brain injury from shaken baby syndrome are over 90% (Sobsey & Nehring, 2005). Violence can also be an indirect cause of academic problems through brain changes related to learning. In the second instance, violence is related to exposure to language, which in turn is related to differences in child language acquisition (Taylor et al., 2009). Parents who communicate with their children using high amounts of negative control (use of anger, criticisms, threats, punishments, slapping and spanking), fewer questions, and more commands and prohibitions, overall, use fewer words and different types of words. Children in these dyads also use fewer words and different types of words but they also use words with fewer morphemes (the smallest part of a word that carries meaning), fewer grammatical word types, and language with fewer different functions (Taylor et al., 2009). These differences in cognitive and language processing, if not remediated early, are direct precursors of learning and cognitive disabilities (Taylor et al., 2009).

One core psychological construct that is linked to both biological changes resulting from violence exposure and language development is executive function deficits (or behavioral self-regulation), which may be central to the connection between academic achievement and mental health problems after violence exposure (see Figure 1). Next, we examine the evidence for these pathways in turn.

Biological Mechanisms

The study of neurobiological processes is one logical avenue of research for further understanding the underlying mechanisms that may produce the co-occurrence of mental health and academic functioning deficits after violence exposure. Childhood is a time of neural plasticity and environmental influences, including abuse and neglect, can impact the developing brain function of children (Weiss & Wagner, 1998). There are three major ways in which, theoretically, alteration of normal brain development can influence learning and behavior (see Figure 2). First, alteration of the neuroendocrine system, neuroanatomical structure (in the form of white matter and grey matter), and brain function may inhibit an individual's ability to develop optimal functioning following exposure to violence. Second, these systems interact and associate with each other to produce cognitive functions (such as executive functioning or cognitive control) necessary for the development of self-regulation and in turn emotional or behavioral functioning. Finally, exposure to violence may influence the developing brain at a critical period making completion of certain core developmental processes difficult, delayed, or impossible. We review the evidence for neuroendocrine disruption, and neuroanatomical functional and structural changes below.

Neuroendocrine Disruption

Autonomic stress response can be measured in humans by systolic and diastolic blood pressure, heart rate variability (or respiratory sinus arrhythmia, a measure of the variability of heart rate over the respiration cycle), galvanic skins response and differences in neuroendocrine expression, in particular the cortisol response. The experience of violence exposure disrupts the autonomic system including blood pressure (Murali & Chen, 2005), heart rate variability (Gordis, Feres, Olezeski, Rabkin, & Trickett, 2010; Heim et al., 2000; Murali & Chen, 2005), galvanic skin response (Gordis, Feres, Olezeski, Rabkin, & Trickett, 2010) and cortisol (Heim et al., 2000; Murali & Chen, 2005; Murray-Close, Han, Cicchetti, Crick, & Rogosch, 2008; Obradović, Bush, Stamperdahl, Adler, & Boyce, 2010). Blood pressure, heart rate variability, and galvanic skin response are physical manifestations of an internal body-brain regulation of hormones, neurotransmitters and metabolic responses. These systems interact under stress in complex ways through the regulation of neurotransmitters, which in turn regulate the release of stress hormones.

Within the neuroendocrine system, cortisol is particularly important as it is involved in the fight or flight response to stress (Meewisse et al., 2007). Cortisol is a glucocorticoid produced by the adrenal gland. Corticotrophin-releasing hormone, a neurotransmitter released by the hypothalamus, is activated by the stress response and begins a cascade by activating adrenocorticotropic hormone in the pituitary gland, that in turn activates the release of the stress hormone cortisol from the adrenal gland. Basal cortisol, cortical diurnal rhythms and cortical reactivity to stress have all been implicated in exposure to stress, but a thorough evaluation of the literature is beyond the scope of this paper. Exposure to violence is related to higher basal cortical levels, greater flattening of the cortisol diurnal rhythm (Cicchetti, Rogosch, Gunnar, & Toth, 2010; Murali & Chen, 2005), and a slower growth in cortisol over the course of development (Trickett, Noll, Susman, Shenk, & Putnam, 2010).

Timing of the child's exposure to violence is particularly critical in changes in cortical response to later stress (Cicchetti, Rogosch, Gunnar, & Toth, 2010; Trickett, Noll, Susman, Shenk, & Putnam, 2010). Early abuse may be particularly damaging (Cicchetti, Rogosch, Gunnar, & Toth, 2010), but timing of abuse in relation to the development of a normative cortisol response in children is particularly difficult to study, as children often experience abuse for a number of years (Trickett, Noll, Susman, Shenk, & Putnam, 2010). Cortisol reactivity is also implicated in reduced school engagement and academic competence (Obradović, Bush, Stamperdahl, Adler, & Boyce, 2010) and the development of psychopathology (Obradović, Bush, Stamperdahl, Adler, & Boyce, 2010; Cicchetti, Rogosch, Gunnar, & Toth, 2010). The developmental stage of the child and the demands of both schooling and social development are likely to influence the behavioral outcomes of abuse at various developmental stages.

Monoamine oxidase A (MAOA) is an enzyme, controlled by the MAOA gene, implicated in the regulation the neurotransmitters serotonin (5-HT), dopamine (DA) and norepinephrine (NE) (Mead, Beauchaine, & Shannon, 2010). Maltreated children with a functional polymorphism in the MAOA gene have increased rates of mental health disorders including attention and emotional problems (Kim-Cohen et al., 2006). Neuroendocrine dysregulation in 5-HT, DA, and NE and related systems has been found in studies of children with violence exposure histories (De Bellis et al., 1999). In this seminal study, maltreated children with PTSD (n=18) were found to have higher urinary epinephrine, norepinephrine, dopamine and free cortisol. Duration of abuse was positively correlated with all four measures while NE and DA were primarily correlated with PTSD symptomatology.

The MAOA gene is also related to a number of other mental health and behavioral outcomes including aggression (Kim-Cohen et al., 2006), depression (Bremner, 2003), antisocial

(Kim-Cohen et al., 2006) and self-regulatory behavioral problems (Kim-Cohen et al., 2006; Oades et al., 2008). Using data from the Environmental Longitudinal Risk study a birth cohort of 975 boys with genotyped data, Kim-Cohen and colleagues examined 62 boys with physical abuse histories compared to matched controls. They examined polymorphisms of the MAOA gene associated with high and low activity of MAOA. Exposure to physical abuse was related to higher mental health problems in both groups. In addition, they found an interaction whereby the Low MAOA polymorphisms had lower mental health problems in the unexposed group but the group exposed to physical abuse with Low MAOA, showed a steeper rise in mental health problems. This same interaction was found for attention, antisocial and emotion problems, if low activity MAOA and no exposure to physical abuse, problems were less than in the high activity MAOA group but surpassed the high activity MAOA if exposed to physical abuse (Kim-Cohen et al., 2006). This suggests that the low activity MAOA polymorphism is a phenotypic risk factor for mental health problems when exposed to the violence. In addition, this work suggests that violence exposure and genetic risk interact to create a vulnerability to different mental health problems, including both aggression and self-regulation.

Self-regulation is particularly important in that it is tied to both mental health and school function through deficits in attention and ADHD. The three primary systems that have been implicated in the development of ADHD are the noradrenergic (NA), dopaminergic (DA) and serotonergic (5-HT) systems (Halperin, Newcorn, & Sharma, 1996). The NA system is the site of function for most ADHD medications, but none of these systems is singularly implicated in ADHD. There is a distinction between children with comorbid aggression and ADHD and those with a more “pure” ADHD (Campbell, Sameroff, Lewis, & Miller, 2000; Halperin, Newcorn, & Sharma, 1996; Lahey, McBurnett, & Loeber, 2000). Reading Disordered (RD) and non-RD children with ADHD differ in their NA response, whereas children who are aggressive and have ADHD differ from pure ADHD in 5-HT response suggesting that the 5-HT system is more central to aggression whereas the NA system may be more central to RD and ADHD (Halperin, Newcorn, & Sharma, 1996).

Brain Development

Research has shown that violence exposure impacts normal brain development. Violence exposure appears to be related to dysfunctional development in brain volumes, white matter development and regional brain function. Violence exposed children have smaller brain volumes in areas related to cognition and emotion processing (Andersen, Tomada, Vincow, Valente, Polcari, & Teicher, 2008), less white matter cohesion (Choi, Jeong, Rohan, Polcari, & Teicher, 2009; Seckfort et al., 2008), dysfunction in dopamine rich brain regions (Sheu, Polcari, Anderson, & Teicher, 2010), and altered lateralization of brain function (Miskovic, Schmidt, Georgiades, Boyle, & Macmillan, 2010). Complicating the science of understanding this link, the timing, duration, and length of exposure determine at what point within normative development, violence exposure influences the brain and what structures and functions are most impacted (Andersen, Tomada, Vincow, Valente, Polcari, & Teicher, 2008). Smaller brain volumes are related to the age at which violence exposure occurs and are a sign of disrupted development. Deficit in white matter cohesion is considered a sign of dysfunctional brain networking. Dopamine rich areas are necessary for the development of self-regulatory function. Finally, altered lateralization is interpreted as a dysfunction in the development of regional functional differences. Normal developmental changes, such as in cortical thickness, are also influenced by individual factors, such as intelligence, which in turn may be influenced by violence exposure (Graham-Bermann, Howell, Miller, Kwek, & Lilly, 2010; Shaw et al., 2006).

Taken together, these findings suggest that violence exposure negatively impacts the neuroendocrine system and brain development during critical periods of the normal

developmental trajectory. This disruption leads to vulnerabilities in systems necessary for cognitive and emotion processing. In particular, neuroendocrine disruption of stress related function and the combination of vulnerabilities in cognitive control and emotion brain areas, can lead to a deficit in self-regulatory processing. Adequate self-regulatory processing is a necessary component of classroom functioning and often is the first school-related psychopathology to raise the attention of schools and parents.

Language Development

The development of the relationship between language disorders and behavior problems can be seen as going through a series of stages that are reviewed in turn below. The first stage is a delay in language development in preschool with its association with attentional problems. In middle childhood, children with reading disabilities and those with a history of language delay show higher rates of internalizing problems. In adolescence, which is associated with a general trend in increased risk behavior, there is a link between unremediated reading disabilities and externalizing behavior problems (see Figure 3).

Early Childhood Communication

One mechanism that has been posited for language disorders leading to problem behaviors is through communication failure. Children with language impairments are more likely to have difficultly with pragmatic language, such as turn taking, which would interfere with their social development and day-to-day communication with peers and teachers. Stevenson (1996) argues that this “communication failure may lead to frustration on the part of language impaired children that may lead to both externalizing and internalizing” (see Figure 3). Social cognitive deficits have also been linked to language impairment. Children with language impairments may experience a decrease in self-esteem (McGee, Share, Moffitt, Williams, & Silva, 1988) putting them at-risk of developing negative social behaviors. Children with language impairment have been shown to have a more limited understanding of emotion in social situations.

The development of self-regulation of emotion and the development of early language are bidirectional. Toddlers express emotion through facial expression and body language but are unable to express emotion through the use of language (Dale, 1996). Toddlers use language in order to communicate in unaroused states. Children progress through stages of language development that allow for increased use of internal state language, or language used to express and describe emotions. Internal state language is developed with five major influences: the maternal language used toward the child, the mother-infant attachment bond, the cognitive development of the child, sibling and peer influences and the child’s style of language learning. There are differences in the ways that boys and girls learn internal state language (Dale, 1996). Both mothers and older siblings have been found to use more internal state language with girls, with a corresponding positive impact on the use of internal state language by girls at 24 months. Children with behavioral problems experience more parental criticism and less parental warmth that may lead to delays in language development (Dale, 1996).

Language Skills

Another model posits that family environment and later hyperactive behaviors may be indirectly linked through language and non-verbal skills. Language skills at 18 months predict hyperactive behavior at 5 years (Girouard et al., 1998). Less educated parents are likely to use fewer words, less complicated syntax and fewer references to events not in the present when communicating with their children (Hart & Risley, 1995). Children in stressed homes are more likely to hear disjointed language and receive irrelevant replies (Dale,

1996). Parents with higher expressive language skills use more physical comforting with their children and more explanations for requests during child conflict situations, rather than demands (Stansbury & Zimmerman, 1999; Taylor, Donovan, Miles, & Leavitt, 2009). Expressive language is related to cognitive development, whereas the use of directive language is related to decreased development of a number of elements of language including total word usage, receptive, sematic and pragmatic language (Murray and Hornbaker, 1997; Taylor, Donovan, Miles, & Leavitt, 2009). Family environment contributes to the language skills of the child, and then, subsequently, children's language skills promote behaviors in primary caregivers that either inhibit or disinhibit emotional regulation, which in turn can lead to externalizing behavior development.

Approximately half of all children with language delays have been reported to exhibit comorbid behavior problems, and by eight years of age language delay is related to increased behavior problems (Benasich, Curtiss, & Tallal, 1993). Children with expressive language delays are more likely to show hyperactive and under-controlled behavior, which is not the case for children with receptive language delays (Stevenson, 1996). The reverse relation has also been found. Among psychiatrically referred children, in one study, over a quarter had previously been diagnosed with Language Impairments (LI) (Cohen, 1993). Children with diagnosed LI differed from those with undiagnosed LI in having more severe expressive language delays but previously undiagnosed children were rated more aggressive and delinquent by their teachers and parents. Approximately 50% of children with ADHD also have speech/language impairments (Tannock & Schacler, 1996).

Vocabulary development is important in the understanding of both aggressive behavior and ADHD. Vocabulary development is related to aggression in 19-month-old twins (Dionne et al., 2003). In this study, aggression and vocabulary growth each have both a genetic and an environmental component. However, the percent of variance explained differed between these two phenotypes, suggesting that they differ in terms of the extent to which genetics and environment influence their development. For aggression, 58% of the variance was explained by genetic factors but for expressive vocabulary, 51% of the variance was accounted for by shared environment, suggesting that family rearing practices play an important role in vocabulary growth. Hart and Risley (1995) found that total number of words spoken in the home vary greatly and are the single strongest determinant of child vocabulary growth.

Reading Skills

Children with language impairments develop reading disabilities at higher rates than children without language impairments. Reading disorders, which by definition cannot be diagnosed until children are reading, have been implicated in the relationship with both internalizing and externalizing problems. Willcutt and Pennington (2000) found both reading disordered girls and boys showed higher rates of ADHD, ODD and CD and had higher rates of anxiety and depression. They also scored higher on Child Behavior Checklist (CBCL) internalizing and externalizing subscales. Results were particularly pronounced with boys in rates of ADHD, ODD and CD and with girls in rates of depression. It is clear there is a transactional relationship between child psychopathology and learning disorders, although the specific mechanisms at work are likely to be diverse and complex. Much less clear is the role of the context in moderating these causal relationships. For children with a history of maltreatment, the context of their maltreatment is integral to their development.

Externalizing, internalizing, and comorbid children have lower IQs (Diamond, Muller, Rondeau, & Rich, 2001; Kusche, Cook & Greenberg, 1993) and reading math and spelling achievement (Kusche et al 1993). ADHD is comorbid with CD, Major Depressive Disorder, Anxiety Disorder, and learning disabilities (LD) or special needs (Faraone, Biederman, &

Keily, 1996). Externalizing and comorbid groups are significantly more likely to be represented in special education (Kusche et al 1993). Children with internalizing disorders have equal rates of oral language problems as those with externalizing problems (Donahue, Hartas, & Cole, 1999). PTSD symptomology predicts lower cognitive functioning (Diamond, Muller, Rondeau, & Rich, 2001). These studies of the correlation between psychopathology and learning problems typically do not address the directionality of effect. It may be that learning problems either pre-date psychopathology or co-occur in early childhood.

Self-regulation

Violence exposure is also to linked to increased internalizing and externalizing behavior through self-regulation. Violence exposure causes decreases in self-regulatory behavior (Kim & Cicchetti, 2009) tied to problems in executive functioning, the ability to plan, organize, and synthesize information (DePrince, Weinzierl, & Combs, 2009; Seckfort et al., 2008). In particular, the relation between self-regulation, psychopathology and academic learning may mediate the development of academic problems after violence exposure.

Mental Health and Academic Problems

One of the most stable findings in developmental psychology is that behavior disorders and other forms of psychopathology are comorbid with cognitive impairment, school failure and learning disabilities such as reading and language disorders (Benasich, Curtiss, & Tallal, 1993; Cohen, Davine, Horodezky, Lipsett, & Isaacson, 1993; Dale, 1996; Donahue et al, 1999). More recent research has shown that there is a bidirectional relation between symptoms that undermine school function and failures in functioning contributing to symptoms (Kim & Cicchetti, 2009; Masten et al., 2005). In one study, the combination of language impairment and parental distress predicted separately to both aggression and delinquency (Brownlie et al., 2004). In another, ADHD and youth with language disorders had high rates of aggression, depression and anxiety symptoms (Mcgillivray & Baker, 2008). Although these rates were subclinical, high rates of mental health symptoms, which do not rise to the level of true mental health disorders, may impact peer and teacher relationships. Both peer and teacher relationships are central to success at school, which means that failures in these relationships are likely to contribute to the circularity of the relation between school academic function and psychopathology (Kim & Cicchetti, 2009).

One interesting study examined adolescent boys exposed to terror attacks (e.g., suicide bombings and shootings) in Israel (Finzi-Dottan, Dekel, Lavi, & Su'ali, 2006). This study compared learning disability (LD) and history of prior exposure as vulnerabilities for the development of mental health problems (in the form of PTSD). Learning disability predicted both avoidance and hypervigilant symptoms in youth with LD suggesting, perhaps, that some core psychological process associated with LD leads to a failure at top-down control over emotion. Illustrating how complicated these interactions are in populations exposed to violence, past history of threatening life events, such as car accident, hospitalization and violence exposure, and parental attachment also predicted PTSD symptoms. Studies of youth with violence exposure and/or behavioral disorders may miss these developmentally complex relations by studying middle childhood or adolescence, where academic problems may have been present but undetected for much of the time prior to study.

Executive Function—Executive dysfunction has been posited as a core neurocognitive function linking psychopathology and academic problems. Executive function is the ability to plan, organize, and delay pre-potent responses in order to reach more complex goals. Failures in executive functioning have been posited as the underlying cause of attention deficit disorder. This higher order skill is seen as necessary in the development of self-

regulation, a deficit seen in children with ADHD. In addition, self-regulation is skill that is integral to the development of language skills and other skills central to school success.

Executive dysfunction has been implicated in the relationship between learning problems and aggression as well. In an early study, Nigg et al. (1999) found that children with lower scores on the Stroop test had later externalizing problems. Séguin, Boulerice, Harden, Tremblay, and Pihl (1999) found that children who showed stable aggression over a six year period performed less well than both unstable aggressive children (those who showed aggression at some assessment periods but not others) and nonaggressive children on tasks of general memory IQ, and frontal lobe tests.

Violence Exposure and Neurocognition—Violence exposed children exhibit neurological changes that might contribute to trouble with learning. A burgeoning literature is showing that family trauma exposure and early life stress are related to poorer executive function (DePrince, Weinzierl, & Combs, 2009; Seckfort, et al., 2008). Several studies by De Bellis have shown that children with abuse and neglect histories have deficits in executive functioning (Beers & De Bellis, 2002; De Bellis, Hooper, Spratt, & Woolley, 2009). De Bellis postulates that neuroendocrine changes in response to stress from abuse and neglect negatively impact the frontal lobe of the brain, causing inattention and other problems associated with executive functioning (De Bellis, 2001; De Bellis, Hooper, Sapia, Vasterling, & Brewin, 2005; Watts-English, Fortson, Gibler, Hooper, & DeBellis, 2006). Violence exposure also has deleterious effects on memory (De Bellis et al, 2009; De Bellis, Hooper, Woolley, & Shenk, 2009; El-Hage, Gaillard, Isingrini & Belzung, 2006) and on performance speed (El-Hage et al, 2006), both skills necessary for successful school functioning.

Childhood executive functioning deficits have been posited as the basis for problems with self-regulation. Students who have difficulty with self-regulation are often removed from normative learning situations, through removal from the regular classrooms, putting them at greater risk of the development of cognitive and language problems. At home, children who lack self-regulation hear more directive language, a correlate with delayed language development (Taylor, Donovan, Miles, & Leavitt, 2009). At school, children are removed from more inclusive environments, also a risk factor for the development of academic skills. In turn, cognitive delays and language processing problems likely play a role in the development of executive function and self-regulation skills. This circular relationship between executive functioning and self-regulation, and language and cognitive processing is difficult to disentangle. However, each type of delay has been connected with internalizing mental health problems. Executive function deficits, self-regulation problems, language processing and cognitive development delays each hamper the child's ability to understand and respond to social cues, which results in withdrawal or acting out in social situations.

Conclusions

The research literature has repeatedly documented a connection between violence exposure and later psychopathology. Previous studies have documented that different types of violence exposure have different outcomes for children. Sexual abuse is particularly damaging in terms of mental health, most specifically in relation to the development of PTSD (Hanson et al., 2008). In terms of educational outcomes, physical abuse is most likely to contribute to special education diagnosis, primarily in the diagnosis of serious emotional disturbance. Sexual abuse was most likely to be related to LD (Jonson-Reid, Drake, Kim, Porterfield, & Han, 2004). This might suggest that PTSD in school is less recognized and has a less marked impact on school-related behavior. It is also possible that the path for sexual abuse might be from abuse to up-regulation of emotion to failure to concentrate,

whereas for physical abuse the path might be from abuse to failure to down-regulate to emotional dysregulation and concurrent academic problems.

Differential pathways based on type of violence have yet to be established. However, the emergence of both externalizing and internalizing adjustment problems can be a critical turning point in the development of violence-exposed children. Most vulnerable to these deleterious effects are those functions that are concurrently developing at the time of violence exposure (Andersen, Tomada, Vincow, Valente, Polcari, & Teicher, 2008). During early childhood, self-regulatory processing and language development can be most impaired in children with mental health problems related to violence exposure. Academic and social functioning can be affected by later exposure. At each stage of development, academic function and social function can work together to impact mental health either positively or negatively.

Social functioning difficulties have implications for school related functioning. Both internalizing and externalizing behavior problems remove students from social learning situations that promote language and cognitive growth. Removal from positive school and family educational settings limits the youth's ability to learn more complex language patterns, organizational skills and self monitoring behaviors as the demands of social and school environment change. The combination of social withdrawal and behavioral problems that lead to smaller, socially removed classroom environments, allow for fewer opportunities to develop self-regulatory skills and social skills necessary for healthy peer-to-peer and adult-to-child relationships.

The reverse is also true. Cognitive processing problems, language delays, and disabilities are often associated with internalizing and externalizing problems. Children with weak language skills may develop, or continue to develop, externalizing problems, internalizing problems, or both through a number of mechanisms. Language impaired children have more difficulty understanding emotions of others and social situations. This may lead to communication failure with other children or adults, which in turn leads to frustration. These children may develop low self-esteem and resort to aggression or withdrawal from others as a result. In early childhood, children with language impairment may appear to be hyperactive or inattentive. In later childhood, language impairment can lead to reading disability, which is associated with both internalizing and externalizing behavior in childhood. In adolescence, children with continued reading disabilities are more likely to show externalizing problems.

There is evidence from cognitive neuroscience that violence exposure causes neurobiological changes that have implications for learning, executive functioning and self-regulation. Findings from neurobiology show that the experience of violence alters the neurochemistry of an individual in ways that may impact learning or may mimic or create learning disabilities. Cascading stress hormones also influence self-regulatory capacity. Children who have experienced violence exhibit abnormalities in a variety of brain regions in cortical thickness, white matter structure and function. It is reasonable to hypothesize that these neurological differences could result in difficulties in school. The frontal region is utilized in planning, setting goals, organizing, and prioritizing information. The temporal lobe is the site of the Wernicke's area, an important site for language comprehension, and the auditory cortex where auditory stimuli are processed. The amygdala is part of the limbic system and has a role in the processing of emotion. Finally, the corpus callosum is necessary for the transfers and integration of information from both halves of the brain. These areas are at-risk for change due to violence exposure.

It is unlikely that different experiences with violence exposure, which are likely to differentially influence the neurobiology of individuals, would have singular or simple

patterns of influence on the learning styles of students. However, it is clear that brain abnormalities are likely to impact sensory processing and integration in a number of distinct ways depending on the individual. In it also clear that repeated maltreatment and traumatic events have a compounding effect on the brain (van der Kolk, 1997, 2003; Van Voorhees & Scarpa, 2004).

We have argued here that cognitive processing and learning problems may be at the center between the known relation between violence exposure and psychopathology. Children with Conduct Disorder can be discriminated from controls by measuring language skills, punishment by parents, ADHD symptoms and oppositional symptoms (Toupin et al., 2000). Children with ADHD show deficits in pragmatic speech and with interpretations of social situations. Pragmatic speech seems to be positively influenced by the use of stimulant medication prescribed for ADHD. The influence of executive function is bidirectional. Executive function influences the development of pragmatic language and social communication and these factors in turn influence the development of executive function (Tannock & Schacler, 1996).

Clinical and Research Implications

Targeted interventions directed at executive function and remediating disability would be essential for assisting children with a history of violence exposure regardless of whether or not their functioning on any of those dimensions rises to the level of a diagnosable disability. Development of cognitive and learning skills is central to the known relation between maltreatment and internalizing and externalizing problems. This would suggest that screening for cognitive deficits and learning problems should be provided to children with histories of violence exposure before they present with problems that reach a clinical cut off in special education or in the realm of mental health.

Future research should focus on the interrelations between executive function, self-regulation, disability and other cognitive processing deficits. Within the cognitive literature, the directions are unclear. Executive function has been posited as a mediator between language and cognitive processing and behavior. This line of research would help to determine cognitive interventions that could moderate the role of cognitive impairments in the development of violence. Another important future direction for research is in determining the extent of neurobiological changes due to timing, duration and extent of exposure to violence and the implications of these changes on the development of language and cognitive processing.

Finally, research might focus on intervention programs that can target specific language and cognitive deficits that have been found to result from the maltreatment of children. Early intervention with at-risk families and their children that focuses on screening for language and cognitive development problems should be incorporated into programs for children at risk of and exposed to violence and those at risk of developing psychopathology. Children who are showing early language and cognitive delays would benefit from programs that provide targeted instruction on infant-caregiver interaction in terms of language and language-rich environments for children.

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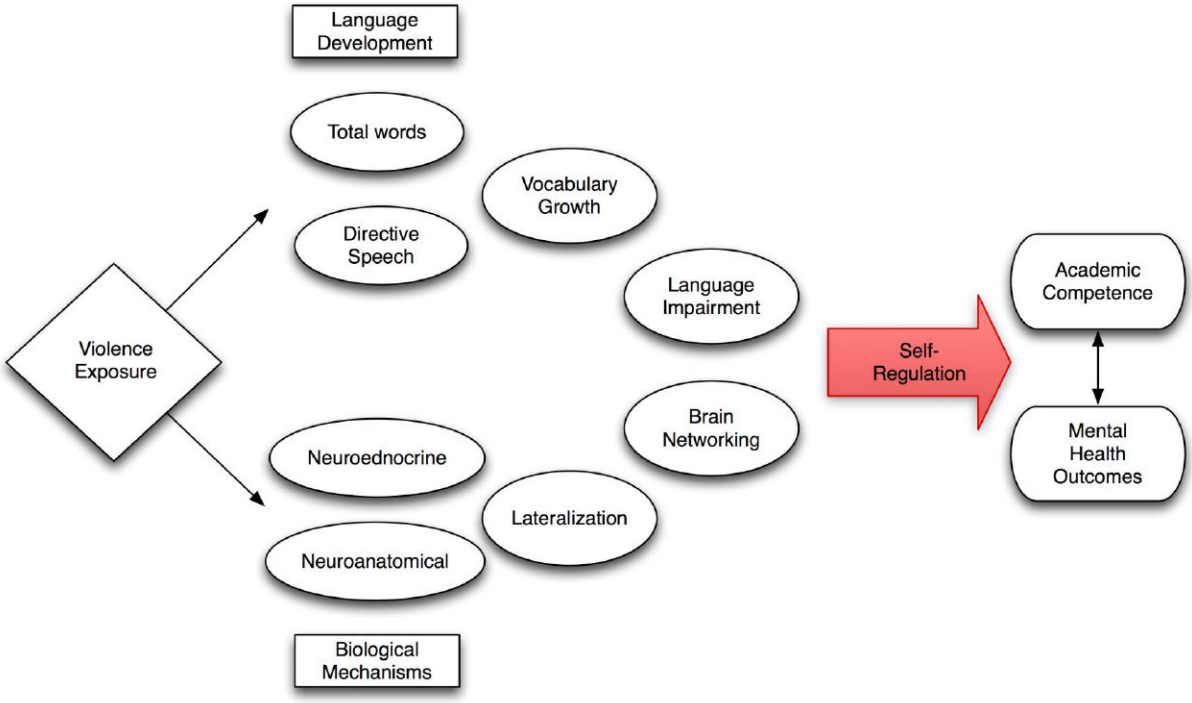

Figure 1.
Graphical Abstract Depicting an Overview of Relations Between Violence Exposure, Academic Function and Mental Health

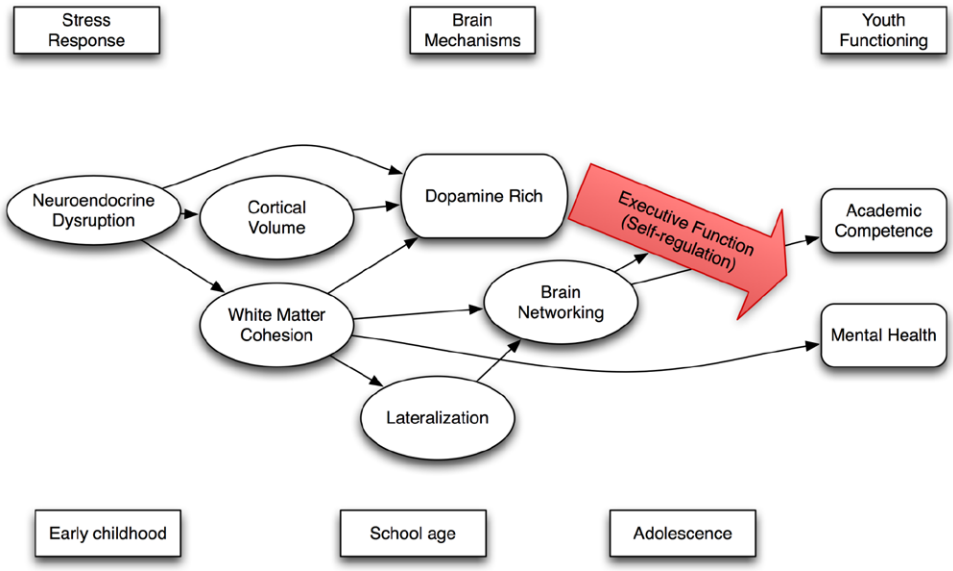

Figure 2.
Biological Mechanisms Related to both Mental Health and School Function

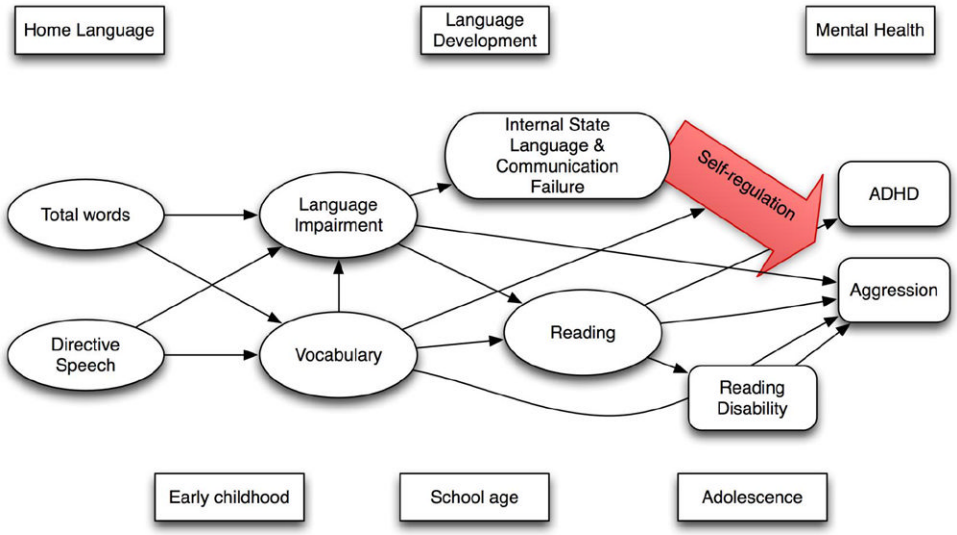

Figure 3.
Developmental Course of Language Development as a Factor in the Development of Mental Health Problems in Children